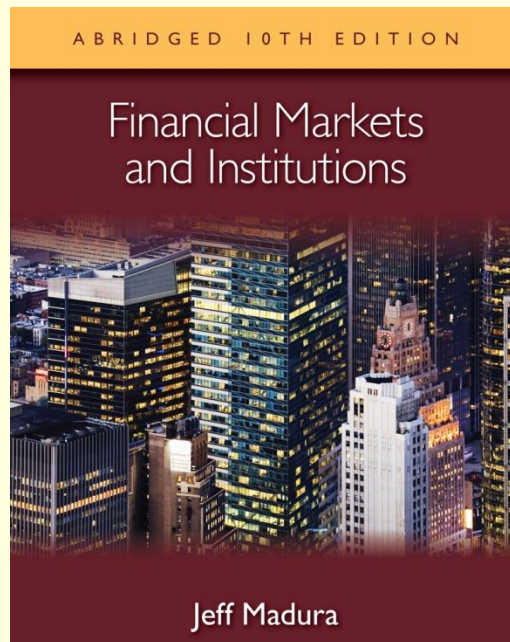


Financial Markets and Institutions

Abridged 10th Edition

by Jeff Madura



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8 Bond Valuation and Risk

Chapter Objectives

- explain how bonds are priced,
- identify the factors that affect bond prices,
- explain how the sensitivity of bond prices to interest rates is dependent on particular bond characteristics,
- describe common strategies used to invest in bonds, and
- explain the benefits of diversifying bonds internationally.

Bond Valuation Process

- Bonds are debt obligations with long-term maturities that are commonly issued by governments or corporations to obtain long-term funds.
- The price of a bond is the present value of the cash flows that will be generated by the bond, namely periodic interest or coupon payments and the principal at maturity.

Bond Valuation Process

Current price of a bond (PV)

$$PV = \frac{C}{(1+k)^1} + \frac{C}{(1+k)^2} + \dots + \frac{C + par}{(1+k)^n}$$

Where:

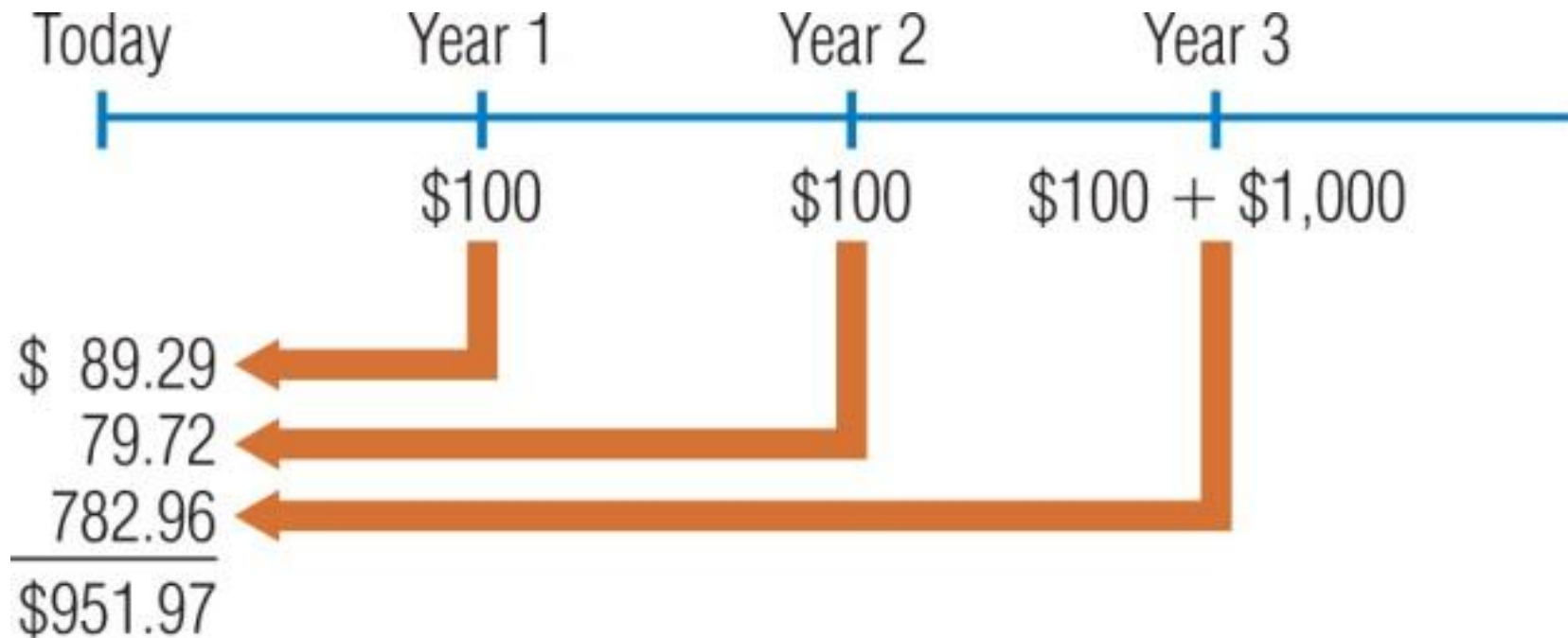
C = coupon payment paid in each period

Par = par value

k = required rate of return

n = number of period to maturity

Exhibit 8.1 Valuation of a Three-Year Bond

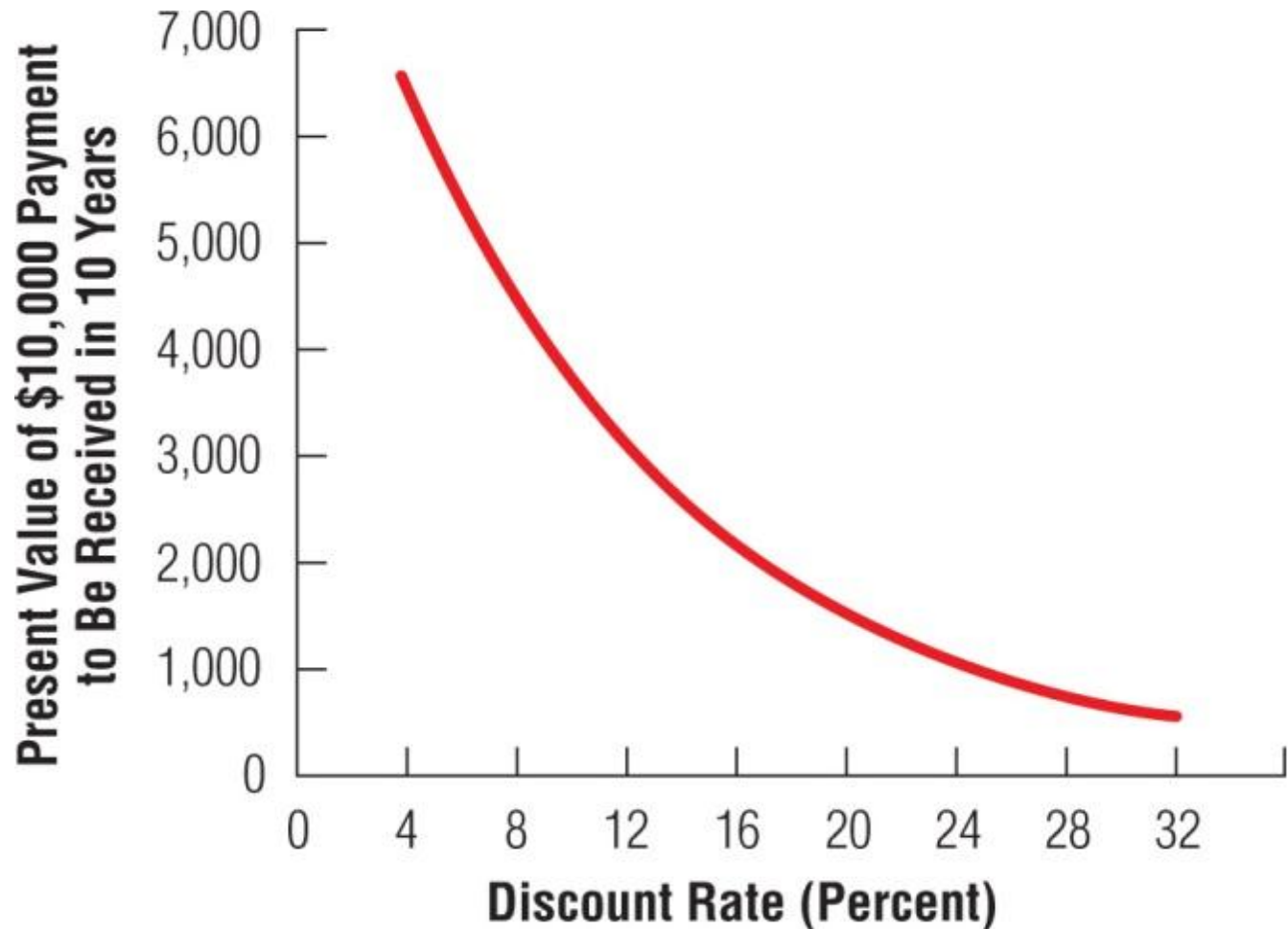


Bond Valuation Process

Impact of the Discount Rate on Bond Valuation

- The appropriate discount rate for valuing any asset is the yield that could be earned on alternative investments with similar risk and maturities.
- High risk securities have higher discount rates.

Exhibit 8.2 Relationship between Discount Rate and Present Value of \$10,000 Payment to Be Received in 10 Years



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Bond Valuation Process

Impact of the Timing of Payments on Bond Valuation

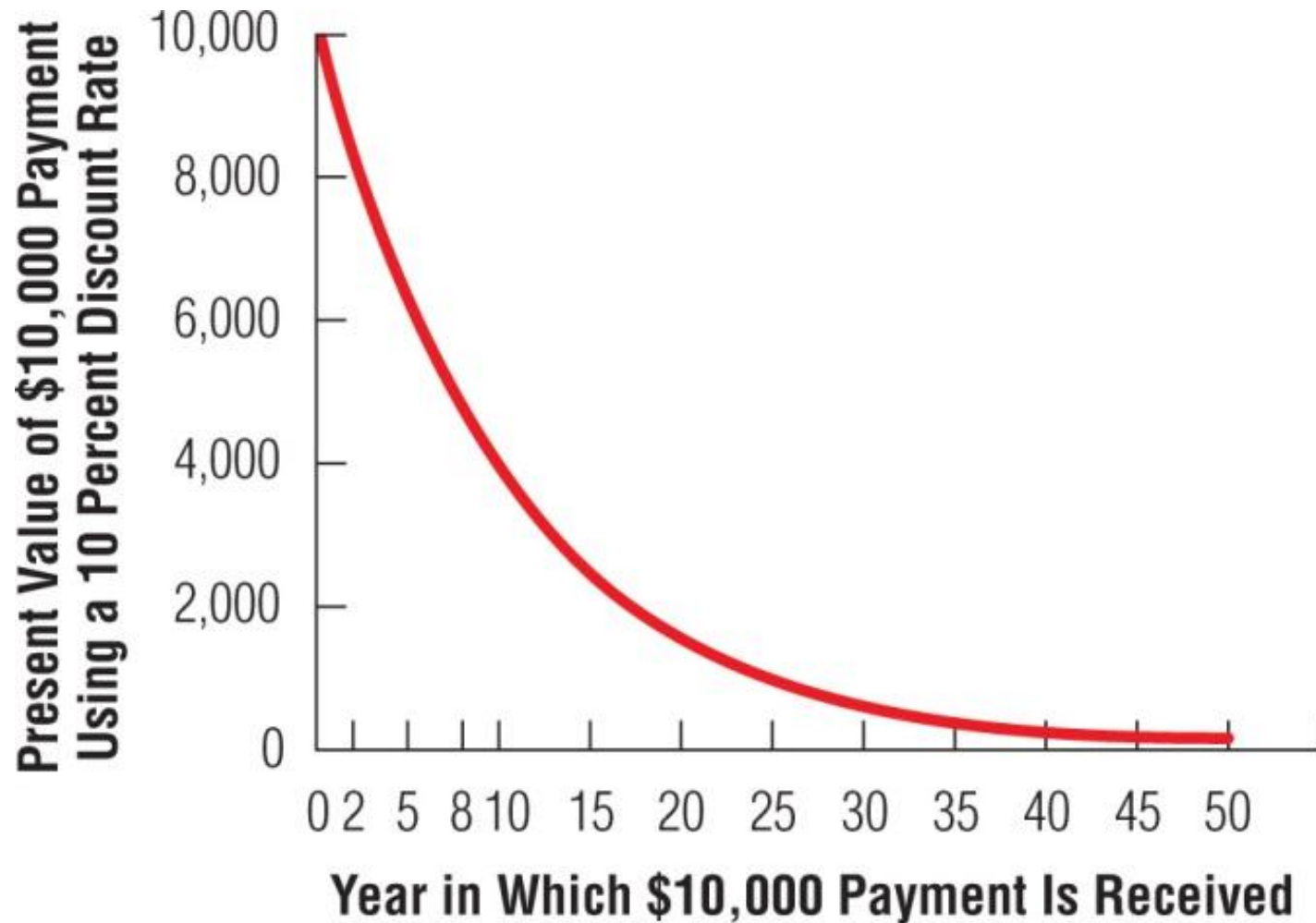
- Timing affects the market price of a bond
- Funds received sooner can be reinvested to earn additional returns

Valuation of Bonds with Semiannual Payments

- First, divide the annual coupon by two
- Second, divide the annual discount rate by two
- Third, double the number of years

$$\text{PV of bond with Semiannual payments} = \frac{C/2}{[1 + (k/2)]^1} + \frac{C/2}{[1 + (k/2)]^2} + \dots + \frac{C/2 + par}{[1 + (k/2)]^{2n}}$$

Exhibit 8.3 Relationship between Time of Payment and Present Value of Payment



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Relationship between Coupon Rate, Required Return, and Bond Price

1. Discount bonds: Bonds Selling below Par

If coupon rate is below required rate, the price of the bond is below par ($PV < 1,000$)

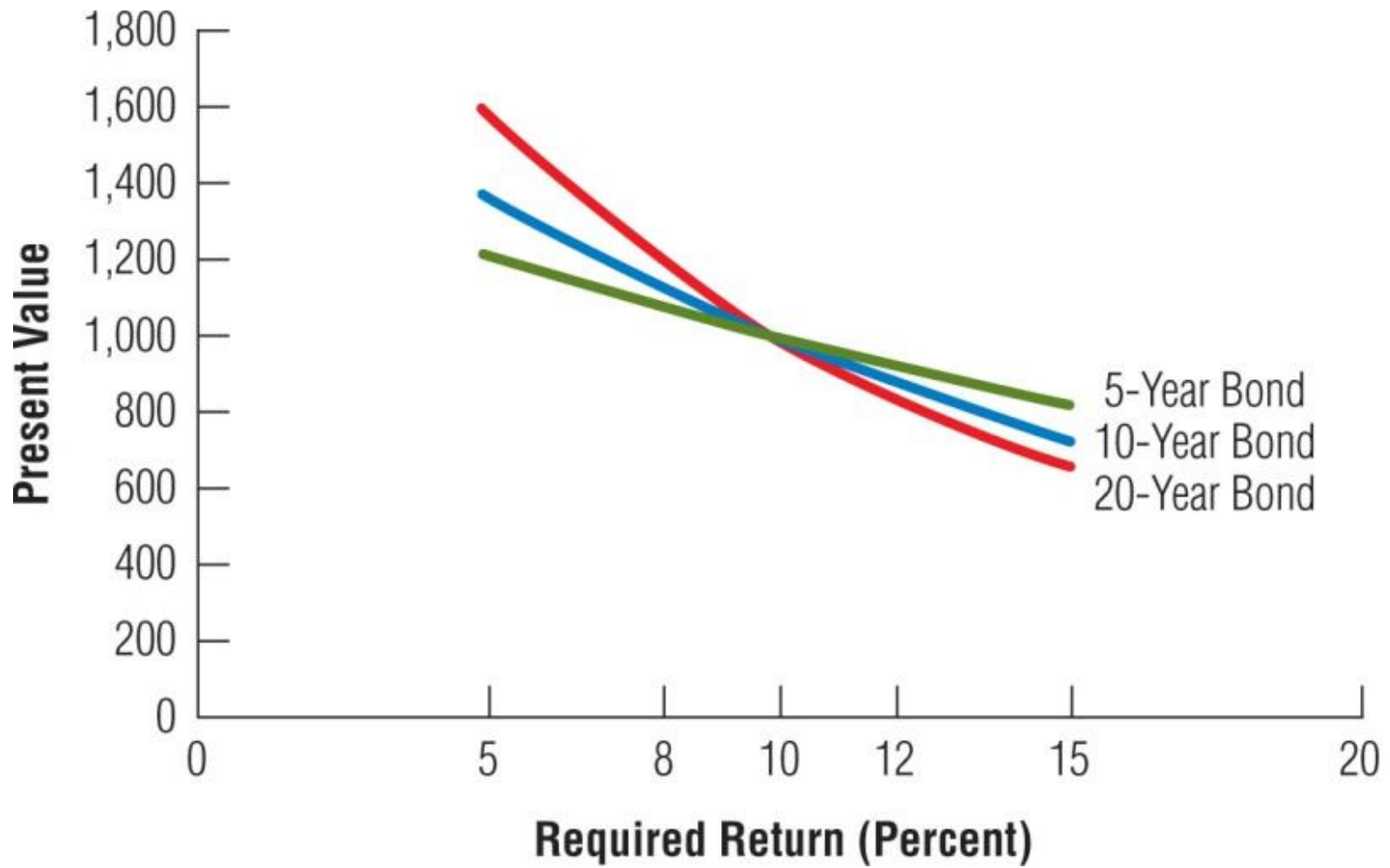
2. Par Bonds: Bonds Selling at Par

If coupon rate equals the required rate, the price of the bond is equal to par value ($PV = 1,000$)

3. Premium Bonds: Bonds Selling above Par

If the coupon rate is above the required rate, the price of the bond is above the par ($PV > 1,000$)

Exhibit 8.4 Relationship between Required Return and Present Value for a 10 Percent Coupon Bond with Various Maturities



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Explaining Bond Price Movements

1. Factors That Affect the Risk-Free Rate

$$\Delta R_f = f(\Delta INF, \Delta ECON, \Delta MS, \Delta DEF)$$

a. Impact of Inflationary Expectations (*INF*)

- If the level of inflation is expected to increase (decrease), there will be upward (downward) pressure on interest rates and hence on the required rate of return on bonds.
- Inflationary expectations are partially dependent on oil prices and exchange rate movements.

b. Impact of Economic Growth (*ECON*)- Strong economic growth tends to generate upward pressure on interest rates, while weak economic conditions put downward pressure on rates.

Explaining Bond Price Movements

1. Factors That Affect the Risk-Free Rate (Cont.)

c. Impact of Money Supply Growth (*MS*)

- i. The increased money supply may result in an increased supply of loanable funds. If demand for loanable funds is not affected, the increased money supply should place downward pressure on interest rates, causing bond portfolio managers to expect an increase in bond prices and thus to purchase bonds based on such expectations.
- ii. In a high-inflation environment, bond portfolio managers may expect a large increase in the demand for loanable, which would cause an increase in interest rates and lower bond prices.

d. Impact of Budget Deficit (*DEF*)- An increase in the budget deficit can put upward pressure on interest rates. An increase in borrowing by the federal government can indirectly affect the required rate of return on all types of bonds.

Explaining Bond Price Movements

2. Factors That Affect the Credit (Default) Risk Premium

The general level of credit risk on bonds can change in response to a **change in economic growth**.

- Strong economic growth can improve a firm's cash flows and reduce the probability of default.
- Weak economic conditions tend to reduce a firm's cash flows and increase the probability of default.

$$\Delta RP = f(\Delta ECON)$$

Explaining Bond Price Movements

2. Factors That Affect the Credit (Default) Risk Premium

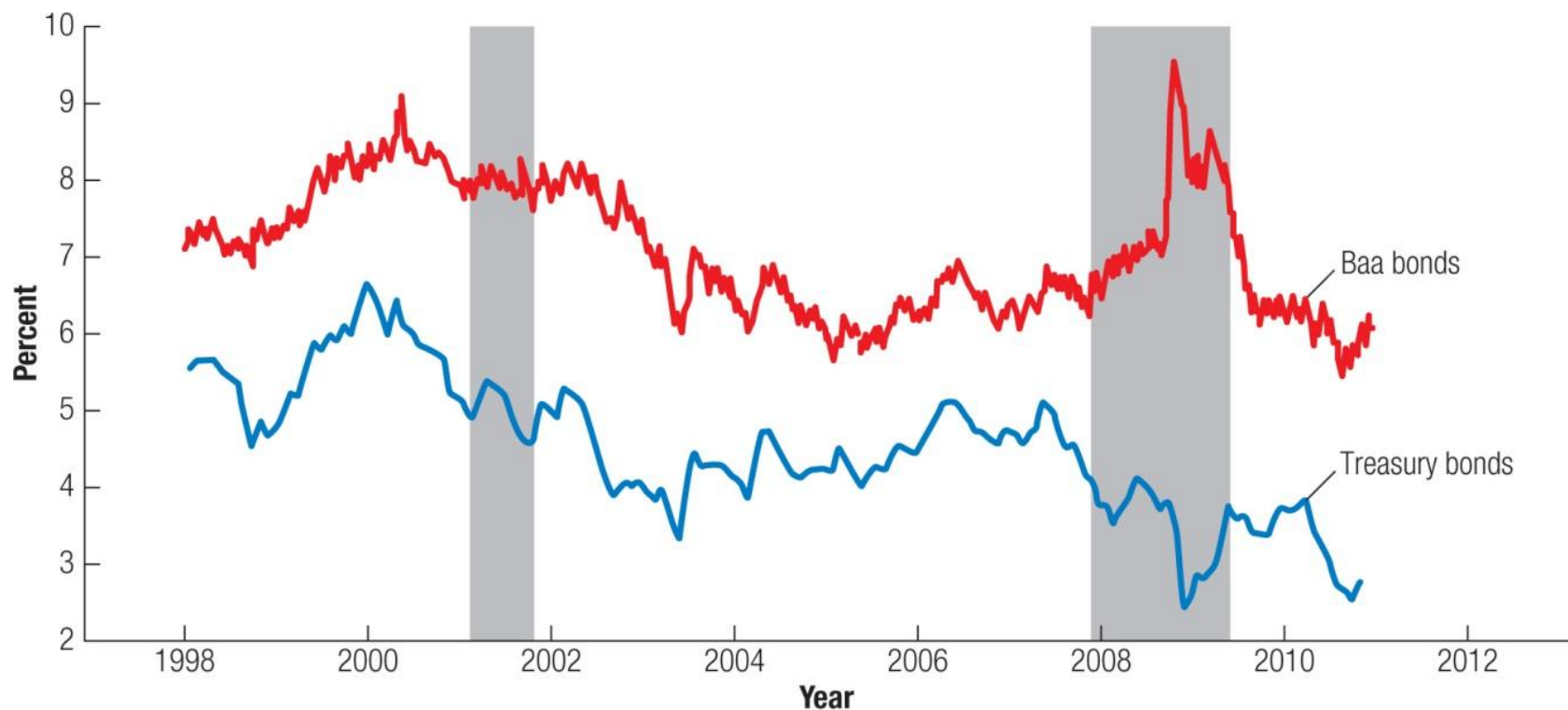
a. Changes in Credit Risk Premium over Time

- Yields among securities are highly correlated.
- Difference between the corporate and Treasury bond yields widened during periods when the economy was weak.

b. Impact of Issuer-Specific Characteristics on Credit Risk

- A bond's price can be affected by factors such as a change in capital structure.

Exhibit 8.5 Bond Risk Premium over Time



Source: Federal Reserve.

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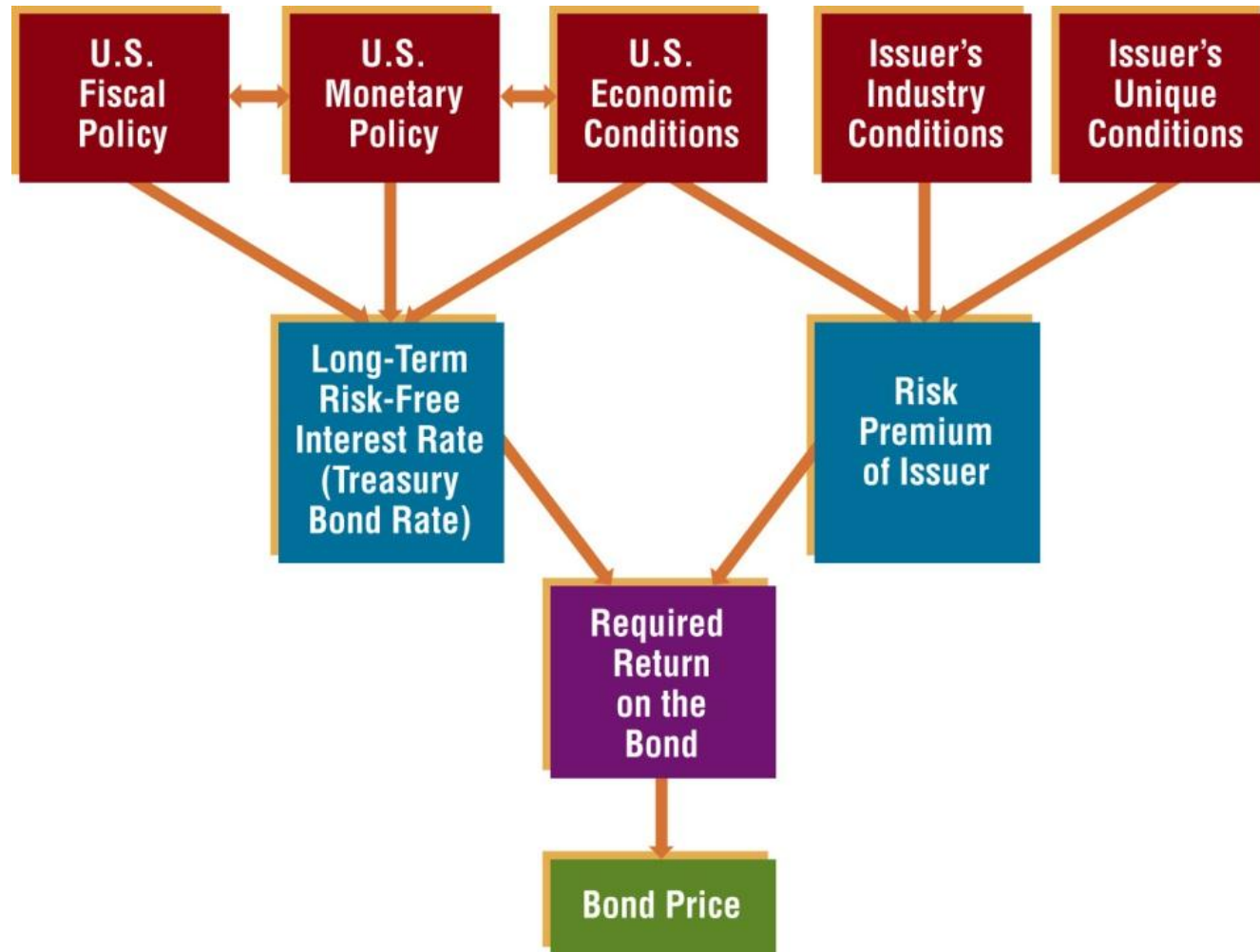
Explaining Bond Price Movements

3. Summary of Factors Affecting Bond Prices

$$\begin{aligned}\Delta P_b &= f(\Delta R_f, \Delta RP) \\ &= f(\Delta INF, \Delta ECON, \Delta MS, \Delta DEF)\end{aligned}$$

- a. The effect of economic growth is uncertain: a high level of economic growth can adversely affect bond prices by raising the risk-free rate, but it can favorably affect bond prices by lowering the default risk premium.
- b. Any new information about a firm that changes its perceived ability to repay its bonds could have an immediate effect on the price of the bonds.
- c. **Systemic risk:** the potential collapse of the entire market or financial system.

Exhibit 8.6 Framework for Explaining Changes in Bond Prices over Time



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Explaining Bond Price Movements

4. Implications for Financial Institutions

- a. Any factors that lead to higher interest rates tend to reduce the market values of financial institution assets and therefore reduce their valuations.
- b. Any factors that lead to lower interest rates tend to increase the market values of financial institution assets and therefore increase their valuations.

Sensitivity of Bond Prices to Interest Rate Movements

- 1. Bond Price Elasticity** - The sensitivity of bond prices (P_b) to changes in the required rate of return (k).

$$P_b^e = \frac{\text{percentage change in } P_b}{\text{percentage change in } k}$$

- a. Influence of Coupon Rate on Bond Price Sensitivity**

- i. A zero-coupon bond is most sensitive to changes in the required rate of return.
- ii. The price of a bond that pays all of its yield in the form of coupon payments is less sensitive to changes in the required rate of return.

- b. Influence of Maturity on Bond Price Sensitivity** - As interest rates decrease, long-term bond prices increase by a greater degree than short-term bond prices.

Exhibit 8.7 Sensitivity of 10-Year Bonds with Different Coupon Rates to Interest Rate Changes

EFFECTS OF A DECLINE IN THE REQUIRED RATE OF RETURN					
(1) BONDS WITH A COUPON RATE OF:	(2) INITIAL PRICE OF BONDS WHEN $k = 10\%$	(3) PRICE OF BONDS WHEN $k = 8\%$	(4) = [(3) - (2)]/(2) PERCENTAGE CHANGE IN BOND PRICE	(5) PERCENTAGE CHANGE IN k	(6) BOND PRICE ELASTICITY (P_b^e)
0%	\$ 386	\$ 463	+19.9%	-20.0%	-.995
5	693	799	+15.3	-20.0	-.765
10	1,000	1,134	+13.4	-20.0	-.670
15	1,307	1,470	+12.5	-20.0	-.625
EFFECTS OF A DECLINE IN THE REQUIRED RATE OF RETURN					
(1) BONDS WITH A COUPON RATE OF:	(2) INITIAL PRICE OF BONDS WHEN $k = 10\%$	(3) PRICE OF BONDS WHEN $k = 12\%$	(4) = [(3) - (2)]/(2) PERCENTAGE CHANGE IN BOND PRICE	(5) PERCENTAGE CHANGE IN k	(6) BOND PRICE ELASTICITY (P_b^e)
0%	\$ 386	\$ 322	-16.6%	+20.0%	-.830
5	693	605	-12.7	+20.0	-.635
10	1,000	887	-11.3	+20.0	-.565
15	1,307	1,170	-10.5	+20.0	-.525

Sensitivity of Bond Prices to Interest Rate Movements

- 2. Duration** - a measurement of the life of the bond on a present value basis. The longer a bond's duration, the greater its sensitivity to interest rate changes.

$$DUR = \frac{\sum_{t=1}^n \frac{C_t(t)}{(1+k)^t}}{\sum_{t=1}^n \frac{C_t}{(1+k)^t}}$$

where

C_t = coupon or principal payment generated by the bond

t = time at which the payments are provided

k = bond's yield to maturity (reflects investors' required rate of return)

Sensitivity of Bond Prices to Interest Rate Movements

2. Duration (Cont.)

- a. Duration of a Portfolio** - the weighted average of bond durations weighted according to relative market value.

$$DUR_p = \sum_{j=1}^m w_j DUR_j$$

where

m = number of bonds in the portfolio

w_j = bond j 's market value as a percentage of the portfolio market value

DUR_j = bond j 's duration

Sensitivity of Bond Prices to Interest Rate Movements

2. Duration (Cont.)

- **Modified Duration (DUR^*):** Can be used to estimate the percentage change in the bond's price in response to a 1 percentage point change in bond yields

$$DUR^* = \frac{DUR}{1 + k}$$

$$\% \Delta P_b = -DUR^* \times \Delta y$$

where $\% \Delta P_b$ = percentage change in bond's price

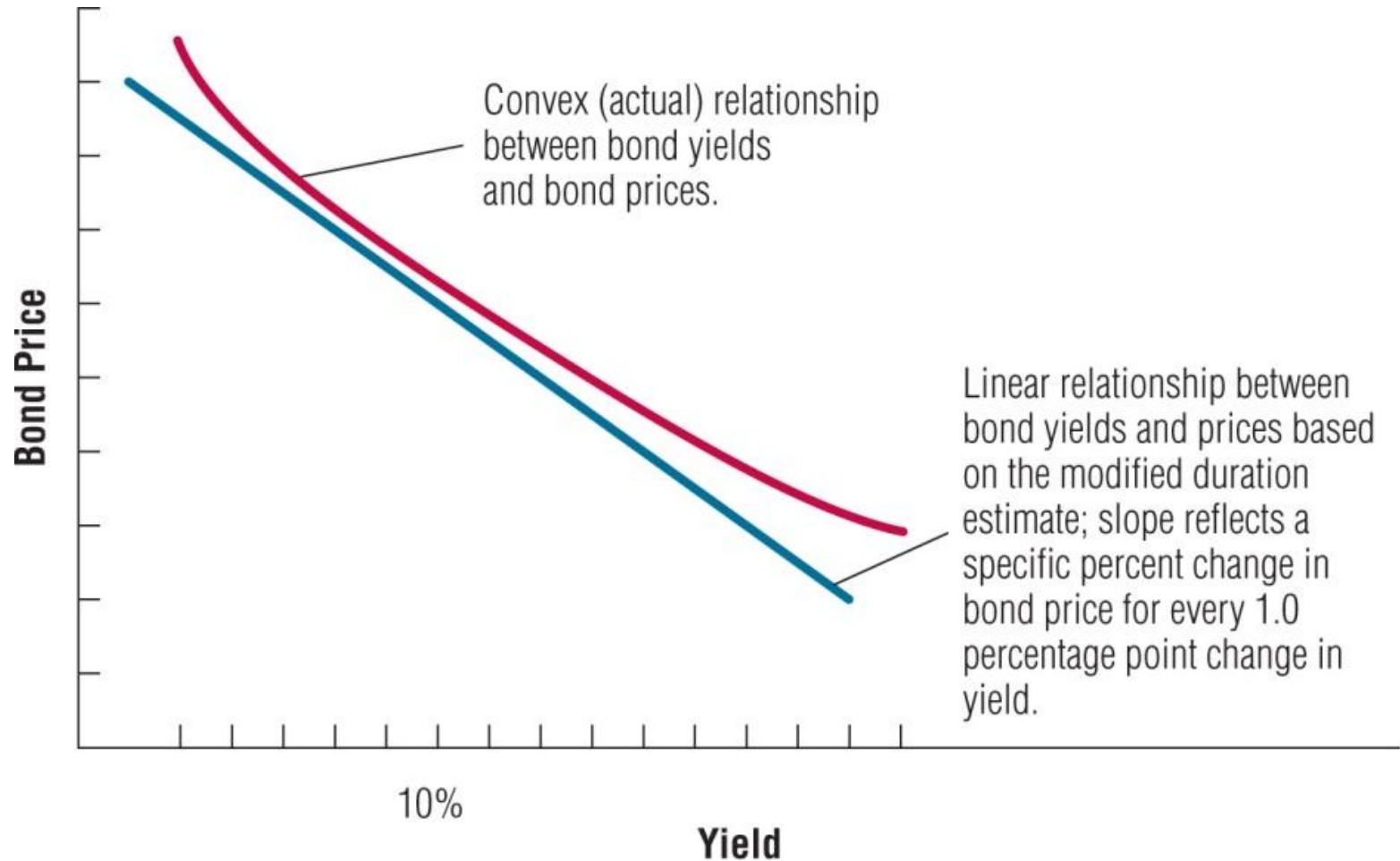
Δy = change in yield

Sensitivity of Bond Prices to Interest Rate Movements

2. Duration (Cont.)

- c. **Estimation Errors from Using Modified Duration** – Relying strictly on modified duration to estimate the percentage change in the price of a bond may lead to overestimating the price decline when rates rise and underestimating the price increase when rates fall.
- d. **Bond Convexity** - The actual response of the bond's price to a change in bond yields is convex and is represented by the red curve in Exhibit 8.8
 - Convexity is more pronounced for bonds with long maturities
 - Convexity is more pronounced for bonds with low (or no) coupons.

Exhibit 8.8 Relationship between Bond Yields and Prices



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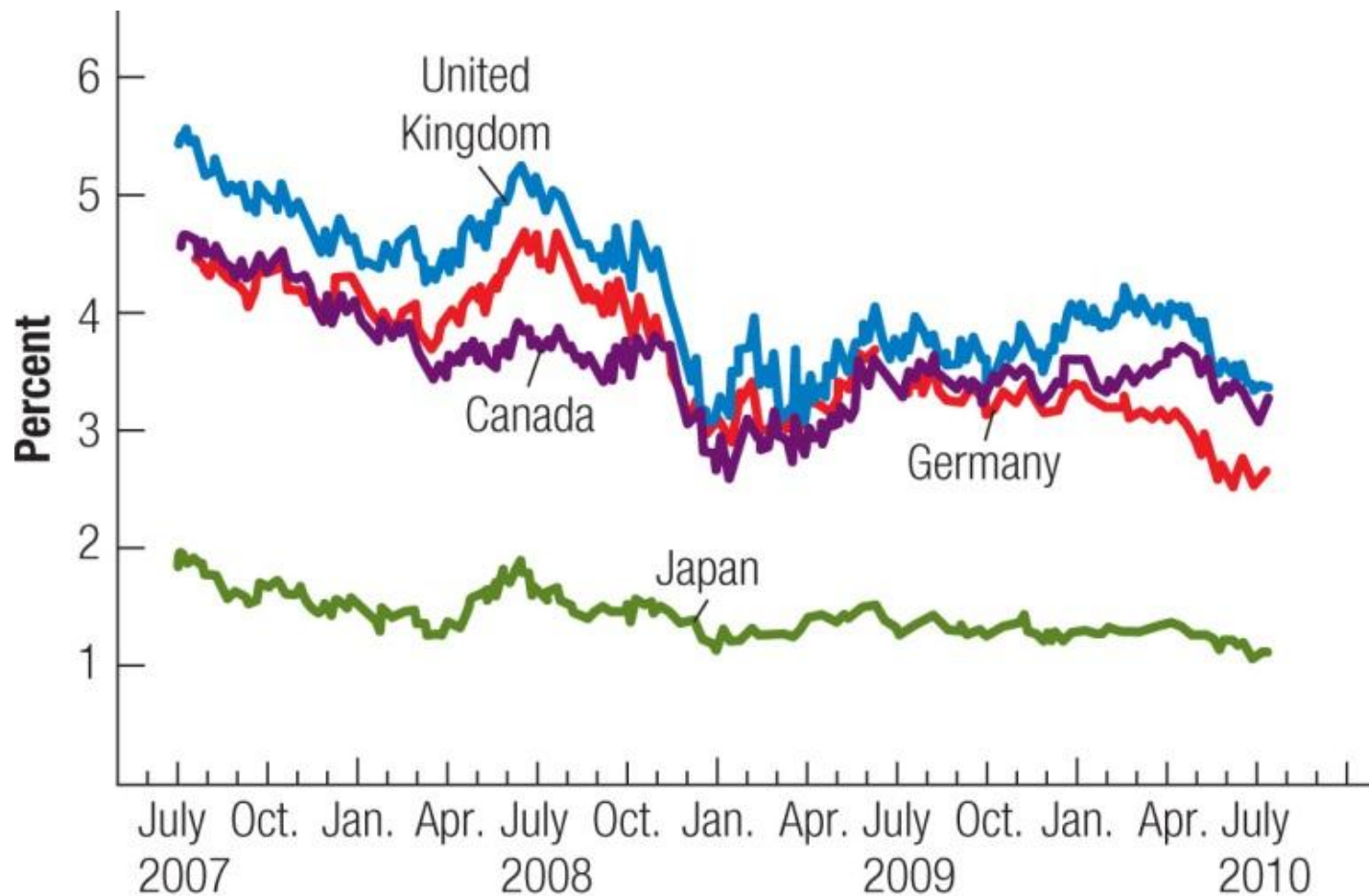
Bond Investment Strategies

- 1. Matching Strategy** - Involves estimating future cash outflows and then developing a bond portfolio that can generate sufficient coupon or principal payments to cover those outflows.
- 2. Laddered Strategy** - Funds are evenly allocated to bonds in each of several different maturity classes.
- 3. Barbell Strategy** - Funds are allocated to bonds with a short term to maturity as well as to bonds with a long term to maturity.
- 4. Interest Rate Strategy** - Funds are allocated in a manner that capitalizes on interest rate forecasts.

Valuation and Risk of International Bonds

- 1. Influence of Foreign Interest Rate Movements** - As the risk-free interest rate of a currency changes, the required rate of return by investors in that country changes as well.
- 2. Influence of Credit Risk** - An increase in risk causes a higher required rate of return on the bond and therefore lowers its present value, whereas a reduction in risk causes a lower required rate of return on the bond and increases its present value.
- 3. Influence of Exchange Rate Fluctuations:** Changes in the value of the foreign currency denominating a bond affect the U.S. dollar cash flows generated from the bond and the return to U.S. investors who invested in it.

Exhibit 8.9 Government Bond Yields over Time



Source: Federal Reserve.

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Valuation and Risk of International Bonds

- 4. International Bond Diversification** - May diversify foreign bond holdings among countries to reduce their exposure to different types of risk
- Reduction of Interest Rate Risk
 - Reduction of Credit Risk
 - Reduction of Exchange Rate Risk

Exhibit 8.10 Dollar Cash Flows Generated from a Foreign Bond under Three Scenarios

SCENARIO I (STABLE POUND)	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
Forecasted value of pound	\$1.50	\$1.50	\$1.50	\$1.50	\$1.50	\$1.50
Forecasted dollar cash flows	\$300,000	\$300,000	\$300,000	\$300,000	\$300,000	\$3,300,000
SCENARIO II (WEAK POUND)						
Forecasted value of pound	\$1.48	\$1.46	\$1.44	\$1.40	\$1.36	\$1.30
Forecasted dollar cash flows	\$296,000	\$292,000	\$288,000	\$280,000	\$272,000	\$2,860,000
SCENARIO III (STRONG POUND)						
Forecasted value of pound	\$1.53	\$1.56	\$1.60	\$1.63	\$1.66	\$1.70
Forecasted dollar cash flows	\$306,000	\$312,000	\$320,000	\$326,000	\$332,000	\$3,740,000

SUMMARY

- The value of a debt security (such as bonds) is the present value of future cash flows generated by that security, using a discount rate that reflects the investor's required rate of return. As market interest rates rise, the investor's required rate of return increases. The discounted value of bond payments declines when the higher discount rate is applied. Thus, the present value of a bond declines, which forces the bond price to decline.
- Bond prices are affected by the factors that influence interest rate movements, including economic growth, the money supply, oil prices, and the dollar. Bond prices are also affected by a change in credit risk.

SUMMARY (Cont.)

- Investors commonly measure the sensitivity of their bond holdings to potential changes in the required rate of return. Two methods used for this purpose are bond price elasticity and duration. Other things being equal, the longer a bond's time to maturity, the more sensitive its price is to interest rate movements. Prices of bonds with relatively low coupon payments are also more sensitive to interest rate movements.
- Foreign bonds may offer higher returns, but they are exposed to exchange rate risk. Investors can reduce their exposure to exchange rate risk by diversifying among various currency denominations.

SUMMARY (Cont.)

- Common investment strategies used to invest in bonds are the matching strategy, ladder strategy, barbell strategy, and interest rate strategy. The matching strategy focuses on generating income from the bond portfolio that can cover anticipated expenses. The ladder strategy and barbell strategy are designed to cover liquidity needs while also trying to achieve decent returns. The interest rate strategy is useful for investors who believe that they can predict interest rate movements and therefore shift into long-term bonds when they believe interest rates will decline.